Trip Report - Visit to CERN - July 7th, 27th 1984

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Abstract

The purpose of the visit was to participate in the second beam test of the Fermilab lithium lens (serial 2). The first beam test was performed during the summer of 1983, when the lens was used as an antiproton collecting lens. For this second test the Fermilab lens was used as a strong focussing element in the 26 GeV proton beam in conjunction with a current carrying target. After the test the lens was left in the beam during regular operation for antiproton accumulation. Operation with the conducting target was terminated due to target failure. At that point the lens had accumulated of the order of 100,000 pulses in a proton beam of 1.3 x 10E13 at a peak current of the order of 330 kAmps.

1-CERN collaboration

The AA group at CERN and the Antiproton Production Group of the Tevatron I project have been collaborating for three years on the general subject of antiproton production and collection. In particular the development of lithium lenses of large aperture has been the subject of many exchanges. The planned upgrade of the CERN AA ring is based on the Fermilab designed lithium lens. At the moment one lens (serial 2) and three transformers have been in location at CERN for beam tests. A second lens will be made available as soon as the requirements of Fermilab's own program are satisfied. The Fermilab design uses water cooling to remove the energy deposited in the lens by the electrical pulse. A CERN SPS group, under the direction of Peter Sievers, from the experience gained at Fermilab started to develop a modified design that could be adapted to gas cooling. The first prototype of such a lens should be available towards the begining of 1985 for power testing at Fermilab. During this trip extensive meetings were held with Sievers and his engineering staff.

Another area of collaboration is in the developing of conducting targets, where an electrical current through the target itself focusses the secondary particles. The first prototypes developed at CERN have been under beam tests in conjunction with the lithium lens. A new conducting target, closer to ideas developed at Fermilab, is now under design at CERN for future tests. Extensive discussions with J. C. Schnuriger of the AA group were held in this regard.

The third area of close interaction between the Fermilab and CERN groups is in the study of the antiproton yields obtained at the AA ring and of those predicted for the Tevatron I project. A detailed comparison of CERN data with the Fermilab calculations has been performed in conjuction with Colin Johnson of the AA group. This collaboration has helped in the understanding of the quality of antiproton collection at CERN, in the design of the instrumentation for measuring antiproton yields in the Debuncher at Fermilab, and in the exploration of targeting and collecting geometries for future upgrades at CERN and at Fermilab.

2-Lithium lens beam tests

During the first week of the CERN visit, the interconnection of a new set of lithium lens monitors and interlocks took place. This new instrumentation replaced the one provided by Fermilab. It is made of 220 volts equipment

of the type normally used at CERN. This will facilitate the accesibility of lens data to the control system, the maintenance and the spare parts problem. The original equipment has now been returned to Fermilab and it serves as spares to the lithium lens test set-up. Also during the first week, help was provided for the commisioning of a new lens water cooling system for the target area. The capability for automatic flushing of the water in case of increased conductivity was also implemented. Accumulation of air in the water system could not be solved before the end of this visit.

The geometry for this beam test was significantly different from that of the summer of 1983. In the previous test the lithium lens was utilized as an antiproton collecting lens, in a similar fashion to that intended for the Tevatron I project. In this present test, the lens was utilized as a strong short focal distance lens for the 26 GeV proton beam. This is an important test in connection with possible future upgrades utilizing conducting targets. The lens was followed by a conducting target and the AA regular horn was used as an antiproton collector.

The lens was located in the proton beam, approximately 1 meter upstream of the conducting target. The focussing of the proton beam (focal distance 1 meter) matches the incoming beam in order to compensate for the strong defocussing produced by the target current (for focussing negative particles). If the divergency of the proton beam at the upstream face of the target matches that expected from defocussing, then a symmetric beta function can be obtained around the centre of the target. This is an important consideration to preserve the possible gains due to the focussing of negative secondary particles by the electrical current within the target. The larger the target current the more the focussing lens with a short focal distance becomes a necessity. Otherwise, the strong defocussing lens would cause a large increase in proton beam size through the target length such that not all the beam will interact in the target.

Proton beam line tunes were worked out to permit a circular proton beam spot of variable radius at the upstream face of the lens. By varying this radius, the convergence of the beam can be varied at the downstream side for a constant focal distance. During the beam tests this radius was varied as a function of the target current to match its defocussing effect.

A total of approximately nine 8 hour shifts of data taking occurred on the last 5 days of the visit. This was sufficient to explore some of the variable parameters at our disposal. A significant increase in the rate of accumulation of antiprotons was achieved. Preliminary numbers indicate of the order of 30 to 40%. The intention all along was not to push components to their maximum capability in order to leave the system for regular operation following the tests. Regular operation at the higher accumulation rate lasted only two days due to the failure of the conducting target. After replacement by the standard target operation was resumed with the lithium lens still in service, to obtain a small proton beam spot at the target, beyond the date of writing this report.

3-Further exchanges with CERN

With the start of instalation of components in the Tevatron I project, CERN personnel has shown a renewed interest in visiting Fermilab to participate in the commisioning of the different systems. At this moment it would be appropiate for Fermilab to extend a general invitation to our CERN colleagues so that a list of possible visits could be generated and appropiate dates suggested.

In the particular case of antiproton production a continuing collaboration is envisage for some time to come.